THE DIPTERA, COLEOPTERA AND OTHER INVERTEBRATES RECORDED FROM OAK SAP-FLOWS AT BRAYTON BARFF, NORTH YORKSHIRE

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Abstract. From 1996 to 2000 a study was made of insects, particularly Diptera and Coleoptera, attracted to sap-flows on two mature pedunculate oaks (*Quercus robur* L.) at Brayton Barff in the modern county of North Yorkshire (VC 61). Several sap-flows were present on each of two trees from July to mid-August and these attracted large numbers of Diptera, Coleoptera and Hymenoptera, together with smaller numbers of Lepidoptera. Over 60 species of Diptera and 26 species of Coleoptera were recorded. Of particular interest was the occurrence of a number of rare, scarce, or stenotopic species characteristic either of sap-flows or diseased trees generally. The Diptera include *Odinia maculata* (Mg.), *O. meijerei* Collin, *Periscelis annulata* (Fall.), *Amiota alboguttata* (Wahlberg), *A. basdeni* Fonseca, *Fiebrigella brevibucca* (Duda), and the Coleoptera, *Soronia grisea* (L.), *Thalycra fervida* (Ol.), *Cryptarcha strigata* (Fab.) and *Cryptarcha undata* (Ol.). It is apparent from this study that trees producing sap-flows attract species other than those dependent on sap itself for their development since several Diptera families and species, not previously associated with sap-flows, are recorded apparently for the first time from this microhabitat. Only a very few of the species recorded are considered to be insect tourists (in the sense that they have no association with the sap-flows). The interesting species recorded from the other insect groups present include the yellow-legged clearwing moth *Synanthedon vespiformis* L. and the hornet *Vespa crabro* L. both of which are scarce in Yorkshire. Comparisons are made with previous studies on sap-flows, the ecology of the species recorded is discussed and implications for habitat management are discussed.

INTRODUCTION

Sap-flows (also known as sap-runs or slime-fluxes) comprise the exudations or liquid ooze that appears on trunks of trees, emanating from openings in the bark. The cause of sap-flows varies but usually involves bacterial infection and is a well-known phenomenon in some species such as the bacterial wetwood in elm *Ulmus* sp. and horse chestnut *Aesculus hippocastanum* L. (Risbeth 1982). Various workers have mentioned the occurrence of different types of sap-flows characterised by colour and other features (for example, Ogilvie, 1924 and Fox-Wilson, 1926). Those on elm *Ulmus* sp. and horse chestnut *Aesculus hippocastanum* are normally described as brown sap-flows and many of the observations of insects on sap relate to these. Brown sap-flows originate from the heart sap wood. On reaching the surface the clear nutrient-enriched liquid turns brown due to feeding by fungi, bacteria and insects (Brown, 1999). White sap-flows represent another type and according to Fox-Wilson (1926) these occur on a wide variety of trees including ash, beech, birch, maple, oak, poplar and willow. The white, frothy sap-flows at Brayton Barff, sometimes smelling strongly of vinegar, fit the description of white slime-flux in Ogilvie (1924) on grounds of colour, smell and tree

species. White sap-flows are alcoholic according to various workers and develop in the bark and sap wood. This type of sap is rich in starches, sugars and proteins and therefore provides ideal conditions for the growth of bacteria (Brown, 1999). Ogilvie (1924) states that this is associated with branch scars, frost-cracks, goat moth (*Cossus cossus* L.) larval borings and other wounds, but that it may also arise from uninjured bark. PFW has observed identical fluxes on oak, *Quercus robur* L., in Herefordshire, following crown fragmentation. The invertebrate fauna associated with brown sap-flows and white sap-flows differs greatly with each characterised by different and distinct suites of insects, with only the white sap-flows covered in this paper.

The invertebrates associated with major white sap-flows on two pedunculate oak trees at Brayton Barff, North Yorkshire are described in this study. These sap-flows were noted during an entomological visit by Ken and Rita Merrifield and the first author was informed of these later that day. A visit was subsequently made which confirmed the unusual extent of the sap-flows with two trees each with circa 15–20 points of sap emanation with a large number of attendant wasps, Diptera and with Coleoptera also obvious. Subsequently, regular visits were made throughout the main period of sap-flow (July–August) over the next three years to record the invertebrates present. The large number of sap-flows, abundance of insect visitors and the fact that these were very obvious even to members of the public, is extraordinary in the first author's experience.

Sap-flows are often cited as an important microhabitat for saproxylic insects (Stubbs, 1972; Key, 1996; Read, 2000). However, observations relating to insects or other invertebrates are infrequent and there are very few detailed accounts in the published literature, even at a world-level. Also, it is clear that a number of specialised saproxylic taxa are closely associated with sap-flows. It is also very clear that saproxylic habitats as a whole represent the most important habitat for rare and uncommon species in Britain (and probably in Europe). It has been suggested that as many as a fifth of all European species of Diptera and Coleoptera are associated with dead wood at some stage of their life-cycles (McLean and Speight, 1993). Furthermore, saproxylic species have been identified as the most threatened community of invertebrates (Read, 2000).

Study site

Brayton Barff is a low wooded hill, with a waymarked nature trail (Anon., 1981), lying adjacent to the village of Brayton, some 4km south-south-west of Selby, in the southern part of the Vale of York. It is one of only two such hills in the area which form obvious features in an otherwise flat landscape. The term "Barff," or "Bargh," signifies a hill or mound.

Description of the trees

The sap-flows examined are on two trees, one (Tree 1) in the centre of what is now a public car park (SE587307), the other (Tree 2) about 400 m distant to the southwest (SE583304). The majority of insect records originate from Tree 1, which divides from the base into three trunks each bearing several large excrescences between ground level and a height of 1.5 m. The sap-flows originate from these excrescences. Tree 2 is rather similar in structure, dividing into four trunks low down, but in this case the excrescences are not as frequent or as well-developed. The low forking nature of the trunks renders girth measurements of limited value.

Fox-Wilson (1926) referred to an oak tree at Wisley in Surrey, showing features very similar to these trees. Other very noticeable excrescent oak trees occur on

Brayton Barff, a few revealing minor sap-flows with attendant *Drosophila*, but no other trees quite like the two described have been encountered at the site. However, members of the public have described other trees at Brayton Barff with large numbers of wasps and flies attracted to them.

Members of the public have confirmed that Tree 1 produces sap-flows perennially, from mid-May until the end of August, but is in greatest evidence in a narrow period from July to early August. The influence of weather on sap-flows was discussed by Fox-Wilson (1926) who found that the sap flow-rate decreased in hot weather. Observations of sap-flow in relation to meteorological conditions have not been made in this study. A further factor that may affect the condition of the trees at Brayton Barff is the proximity of a borehole and pumping station.

Methods

Sampling was by active searching, insects being taken directly from the sap-flows or bark by a tube or pooter. Although quantitative sampling techniques can be applied to tree boles (Kaila, 1993) they tend to eradicate very large numbers of invertebrates, some of which only occur at low frequencies and often result in damage or destruction to the habitat. The collection of larvae or pupae for rearing may well have added to the total number of species recorded, but would have subjected the trees to further damage, which we were keen to avoid. The location of the trees in public areas also precluded the use of trapping methods.

Previous studies

Several general studies of insects associated with sap runs are summarised below. Within the Diptera there also exists an extensive literature on individual families, genera and species particularly pertaining to Drosophilidae.

Study	Tree species	Cause of sap-flows
Christy (1921), Nicolson (1921)	*Ulmus glabra* Huds.	?*Cossus*. Internal stress
Fox-Wilson (1926)	oak	healthy tree, uninjured bark
Keilin (1927)	*Aesculus hippocastanum*	human damage
Shillito (1947)	*Ulmus glabra*	Dutch Elm disease
Assis-Fonseca (1952)	oak	*Cossus* damage
Uffen (1962)	elm	?human damage
Cole and Streams (1970)	elms	bacterial wetwood
	Quercus velutina Lam.	not specified
Chandler (1973)	*Ulmus procera* Salisb.	not specified [?Dutch Elm disease]
Ratti (1978)	*Quercus robur*	frost, mechanical, and *Cossus* damage
Lyszkowski et al (1990)	*Quercus robur*	*Cossus* damage
	Quercus cerris L.	*Cossus* damage
	Quercus sp.	?windfall damage
	Populus tremula L.	not specified
MacGowan (1993)	*Populus tremula*	?wind stress
Whitehead (1996)	*Quercus cerris*	*Cossus* damage
Whitehead (pers. obs.)	*Quercus robur*	major crown breakup
Waterhouse (1998)	*Acer pseudoplatanus*	grazing damage to coppice stems

Results

A list of the invertebrates recorded is provided as Appendix 1.

Diptera

The fauna may be discussed in relation to published information. *Sylvicola punctatus* (Fab.) and other species of *Sylvicola* have been recorded from sap-flows, rot-holes and a wide variety of other saproxylic and non-saproxylic microhabitats (Fox-Wilson, 1926; Keilin, 1927; Cole and Streams, 1970; MacGowan, 1993). Sciarids are very frequent in deadwood situations under bark and in decomposing sapwood (for example, Mohrig, Krivosheina and Mamaev, 1979). Apart from *Sylvicola punctatus* (Fab.), the scatopsid *Coboldia fuscipes* (Mg.) was the only other frequent nematoceran on the Brayton Barff trees. The Scatopsidae are known to comprise several species that utilise rot-holes or other deadwood habitats and Haenni and Vaillant (1994) provide an account of these. According to them, *Coboldia fuscipes* has been reared from a variety of pabula including a large number of species of fungi. Cole and Streams (1970) recorded *Scatopse fuscipes* Mg. from flux that contained detritus.

Drapetis larvae have been reared from under bark and in rotting tree stumps and adults may be found running on tree trunks (Collin, 1961; Teskey, 1976). *Platypalpus* larvae have been reared from a well-decayed hickory stump and from spruce, and have also been found in soil under moss in a wood (Teskey, 1976; Smith, 1989). Several others have been reported from damp earth, humus and beneath fallen leaves (Teskey, 1976). Only one (unidentified) phorid was taken. It is likely that some of the sap-associated beetles and flies on the Brayton Barff trees provide suitable hosts for parasitic phorids. Single examples of the common hoverflies *Episyrphus balteatus* (DeGeer) and *Meliscaeva cinctella* (Zett.) were taken and may have been attracted to the sap although AG is not aware of other records of Syrphini attracted to this medium. *Ferdinandea cuprea* (Scop.) however, is a well-known sap specialist (Smith, 1989; Lyszkowski *et al.*, 1990; Rotheray, 1993); larvae were also found in the sap-flows on several occasions and a specimen was reared from a pupa found on the bark.

Leucopis is perhaps, a surprising genus to find in association with sap-flows. Several females were taken from the bark of Tree 1 on different dates. Certain *Leucopis* are predators of scale insects, aphids, adelgids and mealy bugs on trees, and their presence here may be due to the fact that Tree 1 is subject to stress and this has provided opportunities for Homoptera to exploit the tree along with their chamaemyiid predators. Several species of *Leucopis* are associated with trees in Europe, Russia and North America including *Ulmus*, *Populus* and *Pinus* (Sluss and Foote, 1973; Teskey, 1976). The lonchaeid *Setisquamalonchaea fumosa* (Egger) is a common species found in a wide variety of habitats, having been reared for example, from root vegetables and stems of Apiaceae (Smith, 1989). Its occurrence here may be due to chance.

There appear to be no previous records of dryomyzids, piophilids and carniids associated with sap-flows although the precise woody microhabitat from which Andersson (1999) recorded *Meomira neottiophila* has not been deduced. These are normally regarded as scavenging species, along with certain sphaerocerids, calliphorids, sarcophagids and several muscids, all of which had representatives at Brayton Barff. The abundance of these carrion-feeders on sap has been noted previously (Shillito, 1947). *Mycetaulus bipunctatus* (Fall.) larvae live in rotting fungi, decaying wood, birds nests and probably in dead animals (Zuska and Lastovka, 1965; Ferrar, 1987). *Meomira neottiophila* Collin was not observed on the sap itself but was frequent on bark near the base of Tree 1. They may have been utilising the corpses of

Glischrochilus hortensis (Fourc.) and *Paravespula* from the ground beneath the tree or from the tree itself. They are certainly not associated here with birds' nests or fungi, from which they have been bred in the past. The Swedish term 'kadaverflugor' used by Andersson (1999) for this family would appear to agree well with these observations.

Coproica vagans (Hal.) has been recorded from decaying fungi although they are not thought to be true fungus feeders (Chandler 1990). *Coproica hirtula* (Rondani) and *Spelobia bifrons* (Stenhammer) have similarly been reported from a range of decomposing materials. Richards (1930) recorded *Sphaerocera curvipes* Latreille from the fermented sap of a recently felled oak tree whilst Assis-Fonseca (1952) recorded *Opacifrons coxata* (Stenhammer) on *Cossus* oak. They are occasionally reported from other deadwood situations but they are probably more closely associated with wood-decaying fungi than with wood itself. Odiniids are generally associated with wounded, dying or dead trees and are rarely encountered with the exception of the local *Odinia boletina* (Zett.) (Collin, 1952). *Odinia maculata* has been found on oak infested with *Cossus* larvae and in Windsor Forest in association with the buprestid beetle *Agrilus biguttatus* (Fab.). *Odinia meijerei* which was locally not uncommon on elms when Dutch Elm disease was at its height, has been reared from elm logs (Pechuman, 1937) and from hickory and tulip tree infested with beetles and moths (Ferrar, 1987) and larvae are reported from the tunnels of *Scolytus* on diseased elm. *Odinia meijerei* has also recently been recorded as a parasitoid of the Leopard moth (*Zeuzera pyrina* L., Lepidoptera, Cossidae) (Campadelli, 1995). *O. boletina* develops in bracket fungi (Benson and Walker, 1973; Lewis, 1979; Chandler, 1986; Allen, 1987) although puparia have been found in larval moth borings in walnut twigs in Japan (Ferrar, 1987).

Periscelids are almost always confined to "bleeding" trees and are rarely encountered, even by experienced entomologists. Papp (1988, 1995, 1998) has provided accounts of the larval stages and life habits including that of *P. annulata*, and found larvae in the oozing sap of *Ulmus*. This species was added to the British list from a specimen taken from a sap-flow on beech (*Fagus*) in the New Forest (Lamb, 1904). It has recently been reared from wych elm (*Ulmus glabra*) attacked by Dutch elm disease and *Scolytus laevis* Chapuis (Col., Scolytidae) (Rognes and Hansen, 1996). The drosophilids are amongst the most frequently reported Diptera at sap-flows and the rarely-recorded *Amiota* are virtually restricted to them. *Amiota basdeni* has been recorded on only four occasions in Britain, all from the southeast (Falk and Ismay, in prep.); the Brayton specimens therefore constitute a significant range-extension. One of the existing records is from fallen beech trunks. *Amiota alboguttata* has been reared from the fungus *Daldinia concentrica* (Fries) Cesati et de Notaris (Basden, 1954; Maca, 1980; Smith, 1989; Falk and Ismay *ibid*). Trapping by Basden near Edinburgh in 1952 produced only one *A. alboguttata* below a height of 8.5 m, whilst large numbers occurred between 8.5 and 16 m. The possible significance of this is discussed below. In 1996 *Drosophila subobscura* Collin was the most abundant species at Brayton Barff whilst *D. tristis* Fall., increased considerably during 1997 when the sap flows were less pronounced. Whether this is significant is not clear. *D. tristis* Fall. was recorded by Assis-Fonseca (1952) from *Cossus*-infested oak. *Drosophila busckii* Coq. and *D. hydei* Sturt. were only taken occasionally on the Brayton sap flows. *D. subobscura* Collin has been recorded on slime-fluxes on a variety of trees including *Abies*, *Acer pseudoplatanus*, *Betula*, *Populus*, *Salix*, and diseased *Ulmus* (Basden, 1954; Carson *et al.*, 1981; Shillito, 1947). *Drosophila melanogaster* Mg. proved to be the most frequent drosophilid on the sap runs in 1998. This species is normally associated with fungi and we have been unable to locate records from sap. *Drosophila immigrans* Sturtevant however, has been reported from

sap (Kimura *et al.*, 1977; Stubbs and Chandler, 1978). Several other species observed on slime-fluxes are mentioned in the literature, for example by Assis-Fonseca (1952), Cole & Streams (1970), Teskey (1976), Kimura *et al.* (1977), Carson *et al.* (1981), Ferrar (1987), Smith (1989) and Papp *et al.* (1999). E. B. Basden, carried out a study of drosophilids on sap in Scotland (Basden, 1954).

Few chloropids are associated with decaying or damaged wood. The few published British records of species of *Fiebrigella* are from ancient woodlands and parklands. AG has reared *Fiebrigella brevibucca* from sappy bark from Moccas Park National Nature Reserve (Godfrey, 1998, 2000) and Collin (1946) reared *F. baliola* Collin from material taken from a wounded elm tree. Imagines of *F. brevibucca* have been recorded from the exposed heartwood of beech (*Fagus*) infested by the ant *Lasius brunneus* (Latreille), around sap-flows and at rot-holes in oak. It has also been taken by insecticidal fogging of the oak canopy at Wytham Wood (Falk and Ismay, in prep.).

A single tachinid *Phytomyptera cingulata* (R.-D.) was taken. This species is widespread and mainly parasitises microlepidoptera larvae in rotting wood, fungi or lichens (Belshaw, 1993). Parson (1995) recently recorded it from a standing beech. The calliphorids and sarcophagids recorded comprise common carrion-feeding species, as previously mentioned. Fox-Wilson (1926), Shillito (1947) and Assis-Fonseca (1952) reported several in their studies. Anthomyiids found at Brayton Barff comprise common species which is also true for most of the Fanniidae and Muscidae. One exception is *Fannia aequilineata* Ringdahl, a species reared from a blackbird's nest, wood debris and fungi and one that is strongly attracted to exudates from damaged trees, especially *Cossus* trees (Assis-Fonseca, 1968; Parson, 1995). The other exception is the local *Helina pertusa* (Mg.) which is the only Palaearctic *Helina* associated exclusively with dying or damaged trees. The larvae develop behind loose bark preying upon ceratopogonid, mycetophilid, sciarid, lonchaeid and clusiid larvae. According to Skidmore (1985), it generally favours drier wood than many of the deadwood *Phaonia* species and has been recorded from *Ulmus*, *Fagus* and *Quercus* most frequently. Imagines are infrequently seen since they inhabit shady parts of woodlands where they visit sap-flows or settle on sunlit tree trunks. A single male *Hydrotaea armipes* (Fall.) was reared from sap taken from Tree 1 in 1998. This species develops in a wide range of media including rotting grass, fungi, birds' nests, a sheep carcase, dead snails, compost and rotting seaweed (Skidmore, 1985). This genus is not one normally associated with sap exudations. The common yellow muscid *Thricops diaphanus* (Weideman) has been reared from moss on a rotten oak log and from tree fungi (Buxton, 1960; Chandler, 1973; Skidmore, 1985).

Coleoptera

The fauna is characteristic of oak exudates, but includes a number of generalist species associated with decomposing organic matter in general. The staphylinids *Anotylus tetracarinatus* (Blk), *Xanthonomus longiventris* Heer, *Philonthus nigriventris* Th, *Atheta amicula* (Ste.), *A. trinotata* (Kr.), *A. coriaria* (Kr.), and *A. triangulum* (Kr.) fall into this group. *Philonthus nigriventris* Th. is generally localised and sporadic in Britain, in the experience of PFW usually being noted singly, in decomposing matter of both plant and animal origin. In England, there is some affinity with wooded areas, the species having been noted overwintering in woodland litter. There are only some 6 previous records for VC 61. *Atheta crassicornis* (Fab.) is widespread as an arboreal species, with a strong affinity for basidiomycete fungi.

The elaterid *Hemicrepidius hirtus* (Hbst) has a widespread scattered distribution in the British Isles (Mendel and Clarke, 1996), but is usually encountered singly or in

small numbers. The larvae are associated with tree decay processes. The occurrence of the anobiid *Stegobium paniceum* (L.) is of some interest. This is a cosmopolitan synanthropic species, a map of its British distribution revealing the location of many of our major settlements. The natural habitat of this species is a matter of speculation, but the finding at Brayton Barff may provide a clue; the larvae prefer a diet high in carbohydrates. Analysis of oak slime-flux (Fox-Wilson, 1926) confirmed the expected presence of translocated sugars, which are acceptable to *Stegobium paniceum*, but which apparently do not allow the species to reach "outbreak" proportions. According to Español (1992) *S. paniceum* is "rara en pleno campo" a situation which also pertains in Britain. There is a record by M. L. Denton from Dean Wood, Yorkshire, on 25.11.1983 (*teste* R. J. Marsh).

The nitidulids have similar dietary requirements (Kirk-Spriggs, 1991), many species being positively chemotropic, homing in rapidly on souces of fermenting carbohydrates. A Nearctic species, *Glischrochilus quadrisignatus* (Say) has become known as the picnic beetle in consequence, whilst many nitidulids, such as *Carpophilus sexpustulatus* (Fab.), less generally synanthropic, assemble very rapidly at the freshly exposed sap of fallen live forest trees. *Carpophilus marginellus* Mots., a synanthropic species frequently entering human habitation, was recognised breeding in flux-saturated soil at the base of Turkey oak (*Quercus cerris*) in Worcestershire (Whitehead 1996), whilst Ratti (1978) recorded *C. marginellus* new to Italy in association with *Cossus*-flux on *Quercus robur*. *Carpophilus marginellus* was first recorded in Yorkshire in 1952, with no further records for a further 17 years; recently it has become more widespread (*teste* R. J. Marsh). The larvae of *C. marginellus* appear to require moist niches.

Thalycra fervida is believed to be associated with hypogean fungi of the genus *Rhizopogon* (Kirk-Spriggs, 1996) but the bionomics remain little-known. There are a number of English records at *Cossus*-flux, but only one other Yorkshire and vice-county record, in a light-trap at Cawood (SE53) on 26.8.1990. *Cryptarcha strigata* and *C. undata* are both very strongly associated with sap-flows and *Cossus*-flux (Alexander, 1991; Atty, 1983; Fowler, 1889; Kirk-Spriggs, 1991), but are rare in the north-east of England, *C. undata* here being new to the region. There are two previous Yorkshire records of *C. strigata*, in 1910 and 1986 (*teste* R. J. Marsh). *Soronia grisea* (L.), represented in 1996 by 3 imagines and larvae, is widely scattered in Britain, frequently associated with willow in carr woodland, especially on trees colonised by the fungus *Daedaleopsis confragosa* (Bolton ex Fries) J. Schroet., and overwinters as an imago under bark. There are numerous records for Yorkshire, with a good concentration in the vice-county. *Soronia punctatissima* (Illiger) is also local and is found on flowers as well as on sap-flows.

The weevil *Euophryum confine* (Broun) is a New Zealand species which was unknown in England prior to 1937 and it is now widespread throughout the British Isles (Thompson, 1989; Whitehead, 1992a), colonising both living and processed wood (Hum *et al.*, 1980; Read, 1984; Read, 1991).

Other invertebrates

Large numbers of mites were found amongst sap and drosophilid pupae taken from the sap-flows. AG has previously also found large numbers of mites in horse chestnut sap at Powis Castle Park, Wales and elsewhere. Mites of the genera *Hericia*, *Fusohericia*, *Histiostoma* and *Sellea* prefer fermenting sap (O'Connor, 1994), whilst *Hericia hericia* Kramer was studied on brown slime-fluxes by Robinson (1953). Only one example of the psocid *Trichadenotecnum sexpunctatum* (L.), a localised bark

frequenter, was observed; this is almost certainly an insect tourist. A frequent visitor to the sap was the Red Admiral butterfly (*Vanessa atalanta* L.), one or two of which were present on most visits to Tree 1; this species is well known for its attraction to fermenting carbohydrates (Christy, 1921). Three species of noctuids were found during the day at rest on the trunk of Tree 1. *Acronicta tridens* (D. et S.) and *Oligia versicolor* (Bork.) are both rather thinly scattered in England and Wales, the latter extending to the Scottish lowlands. The larvae of *A. tridens* (D. et S.) feed on woody Rosaceae, whilst *Apamaea monoglypha* (Hufn.) is widespread in Britain, frequently coming to sugar patches, the larvae feeding on Poaceae. A yellow-legged clearwing *Synanthedon vespiformis* L. with partially expanded wings was taken on the bark in 1998. This species is usually associated with *Quercus* although it may also use other tree species. Various sources (e.g. Heath and Emmet, 1985) mention that oviposition may take place in cankerous swellings or excrescences on trunks which are very evident on the trees discussed here.

An especially striking feature was the large number of vespid wasps present, to the extent that a member of the public suggested that they were nesting (in Tree 1). The wasps congregated on the bark around the points of exudation, behaviour which is regarded as typical (Gullan and Cranston, 1994; Whitehead, 1992b; Wilson, 1971). At any one time up to 10 wasps were observed around the 10 to 15 sap exudation points on Tree 1, together with others at rest on the bark, or in slow flight around the tree. As previously noted, the ground around the tree was littered with the corpses of dead wasps. Individual hornets *Vespa crabro* were seen in August and September 2000 on the sap-flows on Tree 1. The individual in August was active and readily took flight whereas the later individual was reluctant to move from one of the few remaining sap emanations and aggressively defended its position. A recently dead wasp in two parts was found on the latter occasion lying next to the hornet and had almost certainly been bitten in two by its larger relative. The hornet is a rare species in Yorkshire with nine previous records (only four since 1970) although it appears to be spreading northwards (Archer, 1998). Few examples of the pompilid *Dipogon subintermedius* (Magretti) were seen. Archer (1989) states that this is encountered only occasionally in Yorkshire and nests in walls, bramble stems and old insect borings in dead wood in sunny, sheltered locations. It has a scattered distribution in England, with a strong affinity for spiders of mature timber habitat or pasture–woodland.

Parasitic Hymenoptera of several species were frequently found flying closely above the tree bark. Those identified are the ichneumons *Liotryphon crassisetus* (Thompson) which is usually a parasitoid of Sesiidae but may attack other Lepidoptera such as leopard moth (*Zeuzera pyrina*) in wood, and *Rhembobius praescrutator* a common parasitoid of hoverfly puparia recorded from around rot-holes (Dr Mark Shaw pers. comm.). Chalcids of the genus *Lissonata* are also parasitoids of microlepidoptera whilst *Calosota* species possibly parasitise xylophagous beetles (Dr Mark Shaw pers. comm.). *Pachycrepoideus vindemiae* (Rondani) is a metallic chalcid which is a pupal parasite of Diptera including species of Piophilidae, Drosophilidae, Calliphoridae and Muscidae all of which are well represented at Brayton Barff.

Discussion

Sap-flows

Explanations for the sap-flows at Brayton Barff remain somewhat obscure. The seeping oak tree described by Fox-Wilson (1926) is a very close analogue; this was

thought to be otherwise healthy. No primary evidence for *Cossus* damage was observed on the trees at Brayton Barff, and the characteristic visible points of rupture of live vascular tissue cut by the larvae were not observed; (the goat moth (*Cossus cossus* L. is also very rare in Yorkshire, according to Sutton & Beaumont, 1989). Excrescences are genotypic features (Longman & Coutts, 1974) reflecting the ability of some oak trees to produce dormant bud-clusters in which large numbers, rather than one or a few, suppressed epicormic shoots may impact on the integrity of the cylinders of cambial, phloem and xylem tissues enclosing the primary trunkwood. At these points there may be physical disruption of the cambial tissues, or access points for bacteria; in North America species of *Erwinia* may produce similar fluxes (Bradbury, 1986), providing opportuntities for the fermentation of translocated sugars.

There is a real possibility that both the trees may be under physiological stress resulting from soil compaction and physical damage by members of the public. Soil compaction can be a serious problem in public car parks (Alexander *et al.*, 1996) resulting in damage to roots and their associated fungal mycorrhizal communities resulting in premature death of trees. Tree 1 is also enticing for children to climb on because it is divided low down into three trunks. Tree 2 may similarly be suffering from soil compaction and physical damage to exposed roots which are exposed on the regularly used footpath. There may also be subsidiary problems in terms of surface run-off not penetrating the compacted soils and competition from surrounding trees particularly tall conifers planted around the perimeter of the car park. It could be that water abstraction from the borehole on the Barff affects the water supply to the trees, acting sporadically as a stress factor and recent hot summers may also have exacerbated the problem.

Diptera

A total of 62 taxa have been recorded at Brayton Barff either directly on the sap or elsewhere on the trunks of the tree. This compares with 40 species recorded by Waterhouse (1998), 33+ by Assis-Fonseca, 23 by Shillito (1947), 20+ by Fox-Wilson (1926), 17 by Cole & Streams (1970), 6 by MacGowan (1993), 4 by Keilin (1927), 3 by Uffen (1962) and 3 by Lyszkowski *et al.* (1990). Both Chandler (1973) and Andersson (1999) also recorded several from sap, heartwood, fungi and associated microhabitats on decaying elm and from various tree species in old parkland respectively. These data show how species-rich the Brayton Barff sap-flows are and how detailed observation can reveal larger faunas. Other recent work by the Malloch Society has revealed the high incidence of rare Diptera species associated with sap-flows (Rotheray *et al.*, in press). The present study confirms that different tree species and different causal processes attract different suites of species. The fauna of the white slime-flux at Brayton Barff is dominated by drosophilids and calyptrates, with very few Nematocera. The fauna therefore bears most resemblance to that of Fox-Wilson (1926) and, as stated above, the description of that tree could equally apply to the Brayton Barff trees. Assis-Fonseca's fauna on a goat moth (*Cossus cossus* L.) damaged tree was also characterised by calyptrates with several species of drosophilids present. However, the rare (but widespread) muscids described by him and reported elsewhere on *Cossus* trees were not found at Brayton Barff although the infrequent *Fannia aequilineata* and *Helina pertusa* proved to be regular visitors. Families more typical of the brown slime-fluxes on horse chestnut (*Aesculus hippocastanum*) and elm (*Ulmus* spp.) sap tend to be dominated by Nematocera (such as Ceratopogonidae, Psychodidae, *Mycetobia*, *Sylvicola* and to a

lesser extent, Limoniidae) and certain other taxa (especially *Systenus*, *Brachyopa* and *Aulacigaster*) (Cole and Streams, 1970; AG pers. obs.). The fauna associated with aspen (*Populus tremula*) sap and associated microhabitats in northern regions also appears distinct (Yerbury: unpublished diaries; MacGowan, 1993; Siitonen and Martikaninen, 1994; Ahnlund, 1996).

Also absent from the trees are a number of other common Diptera recorded from deadwood situations such as *Medetera* (Dolichopodidae) and *Lonchaea* (Lonchaeidae) and clusiids. The latter may be associated with more advanced decay in partly decorticated trees. Further recording may add these, as well as other saproxylic Diptera. What is also surprising is the absence of any of the rarer muscids, like *Phaonia* and *Potamia* species, that are attracted to sap or develop in other deadwood habitats such as *Phaonia canescens* Stein, *P. gobertii* Mik, *P. laeta* (Fall.), *P. pratensis* (R.-D.) or *Potamia querceti* (see Collin, 1951). Several of these species have been bred by the first author from elsewhere in the north of England and North Midlands so that their absence would not appear to be based on absence in this part of the country. There are no obvious fungi on the trees despite the fact that several Diptera recorded have been closely associated with or reared from fungi (for example, *Coboldia fuscipes*, *Mycetaulus bipunctatus*, *Odinia boletina* and *Thricops diaphanus*). These may be occupying other niches or using fungi under bark, at height or otherwise hidden from view although the latter is probably a visitor to the sap.

As previously mentioned, two of the rare species (*Amiota alboguttata* and *Fiebrigella brevibucca*) have been taken at height in trees. It has been suggested that these or other rarely encountered species may normally live within tree canopies, but they are also inconspicuous, often require specialised methods to detect them, and are restricted to localised microhabitats. They probably rarely venture far from where they developed, which may also explain the paucity of records.

Chamaemyiids of the genus *Leucopis* are generally uncommon and extremely unlikely to be encountered in small numbers on bark by chance. For this reason they can be excluded as insect tourists. They are probably predatory on homopterans taking advantage of the stressed tree and as such are symptomatic of an unhealthy tree. The only genuine insect tourists are probably the earwig *Forficula auricularia* and the hoverflies *Episyrphus balteatus* and *Meliscaeva cinctella*, both of which were encountered as singletons on the trunk of Tree 1, and possibly the psocid *Trichadenotecnum sexpunctatum*. Other groups such as the Calyptrates may include tourists but also include species restricted to or preferentially found in saproxylic microhabitats.

It is apparent from this study that trees producing sap-flows attract species other than those dependent on sap itself for their development. An important group are those that are parasitic on wood-boring beetles such as the odiniids, some of which are also thought to be saprophagous in beetle burrows feeding on frass or dead beetles. The numerous dead *Glischrochilus hortensis* and vespid wasps may also afford suitable developmental media for parasitoids. It appears that some of the odiniids may not be restricted to one host or genus, i.e. *Odinia meijerei* on *Scolytus* in *Ulmus* or *O. maculata* on *Cossus*, but may use a range of wood-consuming Lepidoptera or Coleoptera.

Coleoptera

Coleoptera from the Brayton Barff sap-flows regarded by PFW as having conservation status include *Stegobium paniceum* (non-synanthropic contexts only), and the nitidulids *Thalycra fervida*, *Soronia grisea*, *Cryptarcha strigata*, and

Cryptarcha undata. The conservation value of a well-expressed Coleoptera assemblage is greater than that of the sum of its individual species. The oak sap-flow Coleoptera assemblages described by Ratti (1978) for the Varese Prealps, Italy (I) and Whitehead (1996) for Worcestershire, England (E) are defined by the following species (see also Walsh, 1954) of which those marked [B] are represented in the Brayton Barff fauna: *Omalium rivulare* (Pk.) [I], *Atheta euryptera* (Ste.) (I,E), *Atheta harwoodi* Williams [B,E], *Atheta gagatina* (Baudi) [I], *Thamiarea cinnamomea* (Grav.) [I], *Thamiarea hospita* (Maerkl.) [I,E], *Aleochara sparsa* Heer, [E], *Stegobium paniceum* [B], *Carpophilus marginellus*, [B,I,E] *Epuraea guttata* [I], *Epuraea unicolor* [B,I,E], *Soronia grisea* [B,I,E], *Soronia punctatissima* (Ill.) [E], *Thalycra fervida* [B] *Cryptarcha strigata* [B,I,E], *Cryptarcha undata* [B], and *Litargus connexus* Geoff. [I,E]. This represents a broad European arboreal oak-based assemblage of strong conservation value.

Other insects

The cause of death of vespid wasps scattered around the base of Tree 1 is unknown, but appears to be related directly to the process of imbibing from the sap-flows. Some deaths may have been caused by hornets but this species was only encountered during the last two visits to the site in 2000 and is therefore unlikely to account for the deaths seen in earlier visits. Christy (1921) described dead wasps from *Ulmus* sap in Essex and suggested that the most likely cause of death was from intoxication although some may be due to attacks from hornets. Shillito (1947) also observed hornets attacking wasps and, in south-east Europe, PFW has observed intense activity involving both hornets *Vespa crabro* and other wasps *Paravespula* sp., at sap-flows, certain populations of the former developing into fiercely active predators of the latter.

Although no night visits were made to the trees, it is strongly suspected that the noctuids fed at night on the sap, as has been observed on diseased elms (Nicolson, 1921; Shillito, 1947).

Parasitic Hymenoptera were much in evidence around the trees. Those identified are parasitoids of hoverflies, clearwings and (other) micro-moths. It may be significant therefore that the hoverfly *Ferdinandea cuprea* was breeding in appreciable numbers in the sap and that yellow-legged clearwing was also recorded. The Parasitica were only partly sampled but comparison of their preferred hosts and the assemblage at Brayton Barff shows many similarities and indicates the close association this group has with sap-flows and diseased trees.

Implications for habitat and tree management

The main point for habitat management resulting from this study is the importance of damaged and diseased trees to uncommon and rare invertebrates. Cankers and sap-flows as well as other features such as rot-holes, crown dieback, limb damage through windthrow, lightning or other means and associated bracket fungi are regarded negatively by foresters, arboriculturalists and landowners. Trees with these features may be seen as requiring remedial treatment or even removal. The features associated with diseased or damaged trees therefore need to be viewed more positively by those responsible for managing the trees. Where there is risk to the public from diseased or damaged trees, for example along public footpaths, a more considered assessment of the options should be undertaken that will include the

retention of the trees and ensure public safety. This might include for example, the removal of overhanging or topheavy limbs rather than the entire tree.

The importance of diseased trees to rare invertebrate species was demonstrated clearly in the 1970s with the outbreak of Dutch Elm disease. This led to an increase in sap-flows on elms *Ulmus* spp. which in turn proved favourable to the Nationally Scarce *Odinia meijerei* (Diptera, Odiniidae) and led to an increase in the number of records of this uncommon species (Benson & Walker, 1974; Lewis, 1979). The decrease in elms through disease subsequently was matched by a near cessation in records of the fly.

Physical damage, soil compaction, drought (both natural and man-made) and competition from nearby conifers are also considered to be factors causing or exacerbating the poor health of the trees studied. With the exception of the former, it is probably unlikely that introduction of one or more of these features will create conditions suitable for saproxylic species. Physical damage to trees and even killing, however, has been advocated elsewhere as a means of providing a habitat for these rare wood-associated species (Alexander *et al*., 1996 provide a summary of various methods). Ahnlund (1996) also proposed the mutilation and killing of aspens *Populus tremula* in Sweden as a means of protecting rare saproxylic species and this has recently been adopted in Scotland (I. MacGowan pers. comm.). Clearly, the adoption of such extreme measures, could only be considered where there is a large supply of trees so that individuals can be sacrificed and where there is active regeneration. The absence of these two factors is likely to preclude the widespread adoption of this approach in Britain. Such measures could be adopted with non-native species such as sycamore (*Acer pseudoplatanus*) and horse chestnut (*Aesculus hippocastanum*) since these species are also utilised by native saproxylic invertebrates (AG pers. obs.).

The study also shows that trees valuable to saproxylic invertebrates can occur away from designated sites and from well-known ancient woodlands and medieval parks. Such trees may be as valuable as those within designated sites. Although Brayton Barff is a SINC (Site of Importance for Nature Conservation) and is partly ancient woodland, this has not prevented the removal of all trees regardless of age or species in a broad band just to the south of the carpark for maintenance by the local water authority. A surprising fact obtained during the course of this study is that a tree has to be 'sound' for a Tree Preservation Order designation to be bestowed upon it. Whilst the reasons for this are clear to understand, it would mean that nature conservation comes second to the risk of litigation.

Conclusions

The importance of sap-flows for invertebrates is confirmed, in particular for Coleoptera and Diptera, both of which include specialist species with a strong level of association to them, as well as numbers of more generalist and opportunistic species. It is apparent from this study that trees producing sap-flows attract species other than those dependent on sap itself for their development, although very few are considered insect tourists (in the sense that they have no association with the sap-flows). Several Diptera families, including some of the carrion feeders, appear to be recorded for the first time from sap-flows, including the Carniidae, Piophilidae and Dryomyzidae. Rare Diptera recorded include *Amiota basdeni* Fonseca (four previous British records), *A. alboguttata*, *Odinia maculata*, *O. meijerei*, *Periscelis annulata* and *Fiebrigella brevibucca*. The high incidence of rare Diptera mirrors other recent work

carried out by the Malloch Society (Rotheray *et al.*, in press). Amongst the Diptera there proved to be certain absentees which otherwise might be expected on well-developed sap-flows. These were particularly amongst the Muscidae and their absence cannot be due to biogeography since several of these rare saproxylic species have been encountered by the first author elsewhere in the north of England. A number of the Coleoptera, particularly the Nitidulidae, are notable species of conservation status, especially in the regional context. The Lepidoptera and Hymenoptera also include representatives including the uncommon yellow-legged clearwing *Synanthedon vespiformis* and the hornet *Vespa crabro*. Visually and numerically the vespid wasps form a conspicous and important part of the fauna whilst the importance of the Parasitica which were also frequent has been underplayed due to lack of expertise and lack of information on this group.

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Appendix I

Invertebrates recorded on or by oak-sap at Brayton Barff

The status of the Lepidoptera and Diptera is taken from the environmental recording package Recorder version 3.2. The status of the other groups is taken from Recorder or from the specialists consulted.

TAXONOMIC LIST

ACARINA	
sp. indet.	
DERMAPTERA	
Forficula auricularia L.	Common
PSOCOPTERA	
Trichadenotecnum sexpunctatum (L.)	Local and scattered
LEPIDOPTERA	
NYMPHALIDAE	
Vanessa atalanta L.	Migrant and resident
NOCTUIDAE	
Apamea monoglypha (Hufn.)	Common
Acronicta tridens (D. et S.)	Local
Oligia versicolor (Bork.)	Local
SESIIDAE	
Synanthedon vespiformis (L.)	Nationally Scarce
COLEOPTERA	
CARABIDAE	
Trechus quadristriatus (Schr.)	Common and widespread
HYDROPHILIDAE	
Helophorus obscurus Muls.	Common and widespread
STAPHYLINIDAE	
Anotylus tetracarinatus (Blk.)	Common and widespread
Xantholinus longiventris Hr.	Common and widespread
Philonthus nigriventris Th.	Localised and infrequent
Atheta harwoodi Will	Local, widely scattered
Atheta amicula (Ste.)	Locally common
Atheta coriaria (Kr.)	Common
Atheta trinotata (Kr.)	Common and widespread
Atheta coriaria (Kr.)	Local, widely scattered
Atheta triangulum (Kr.)	Local, widely scattered
Atheta crassicornis (Fab.)	Common and widespread

ELATERIDAE	
Hemicrepidius hirtus (Hbst.)	Infrequent, widespread
ANOBIIDAE	
Stegobium paniceum (L.)	Usually synanthropic
NITIDULIDAE	
Carpophilus marginellus Mots.	Localised, often synanthropic
Meligethes aeneus (Fab.)	Common and widespread
Epuraea unicolor (Ol.)	Common and widespread
Soronia grisea (L.)	Local, widely scattered
Soronia punctatissima (Illiger)	Local
Thalycra fervida (Ol.)	Nationally Scarce. Localised
Cryptarcha strigata (Fab.)	Nationally Scarce. Localised
Cryptarcha undata (Ol.)	Nationally Scarce. Localised
Glischrochilus hortensis (Fourc.)	Common and widespread
LATHRIDIIDAE	
Corticarina fuscula (Gyll.)	Common and widespread
MYCETOPHAGIDAE	
Typhaea stercorea (L.)	Widespread, often synanthropic
CURCULIONIDAE	
Euophryum confine (Brn.)	Naturalised, widespread

DIPTERA

ANISOPODIDAE	
Sylvicola punctatus (Fab.)	Common
SCIARIDAE	
Sciara thomae (L.)	Common
Sciaridae indet. (females)	
SCATOPSIDAE	
Coboldia fuscipes (Mg.)	Common
HYBOTIDAE	
Drapetis nigritella (Zett.)	Local
Platypalpus longiseta (Zett.)	Common
PHORIDAE	
Phoridae indet. (female)	
SYRPHIDAE	
Episyrphus balteatus (DeG.)	Common
Meliscaeva cinctella (Zett.)	Common
Ferdinandea cuprea (Scop.)	Local
DRYOMYZIDAE	
Neuroctena anilis Fall.	Common
CHAMAEMYIIDAE	
Leucopis (Leucopis) sp. (females)	
SPHAEROCERIDAE	
Coproica hirtula (Rondani)	Common
Coproica vagans (Hal.)	Common
Spelobia bifrons (Stenhammer)	Local
LONCHAEIDAE	
Setisquamalonchaea fumosa Egger	Common
PIOPHILIDAE	
Mycetaulus bipunctatus Fall.	Regionally Scarce (Northern England)

ODINIIDAE	
Odinia boletina (Zett.)	Local
Odinia maculata (Mg.)	RDB3
Odinia meijerei Collin	Nationally Scarce
CARNIIDAE	
Meonura neottiophila Collin	Regionally Scarce (Northern England)
PERISCELIDAE	
Periscelis annulata (Fall.)	Nationally Scarce
DROSOPHILIDAE	
Amiota alboguttata (Whlbg.)	Notable
Amiota basdeni Fonseca	RDB2
Drosophila busckii Coq.	Common
Drosophila funebris (Fab.)	Unknown
Drosophila hydei Sturt.	Regionally Scarce (Northern England)
Drosophila immigrans Sturt.	Common
Drosophila melanogaster Mg.	Local
Drosophila subobscura Collin	Common
Drosophila tristis Fall.	Regionally Scarce (Northern England)
CHLOROPIDAE	
Fiebrigella brevibucca Duda	Nationally Scarce
CALLIPHORIDAE	
Calliphora vicina R.-D.	Common
Calliphora vomitoria (L.)	Common
Lucilia ampullacea Villeneuve	Local
Lucilia caesar (L.)	Common
Lucilia illustris (Mg.)	Common
Pollenia pallida Rodendorf	
Pollenia rudis (Fab.)	Common
SARCOPHAGIDAE	
Sarcophaga variegata (Scop.)	Common
TACHINIDAE	
Phytomyptera cingulata (R.-D.)	Uncommon but widespread
ANTHOMYIIDAE	
Lasiomma seminitidum (Zett.)	Common
Anthomyia procellaris (Rondani)	Common
Delia coarctata (Fall.)	Common
Delia platura (Mg.)	Common
Pegomya sp. (females)	
FANNIIDAE	
Fannia aequilineata Ringdahl	Local
Fannia canicularis (L.)	Common
Fannia manicata (Mg.)	Common
Fannia scalaris (Fab.)	Common
MUSCIDAE	
Hydrotaea armipes (Fall.)	Common
Thricops diaphanus (Wied.)	Common
Muscina levida (Harris)	Common
Muscina prolapsa (Harris)	Common
Phaonia errans (Mg.)	Common
Phaonia pallida (Fab.)	Common
Phaonia rufiventris (Scop.)	Common

Phaonia subventa (Harris)	Common
Phaonia trimaculata (Bouche)	Frequent
Phaonia valida (Harris)	Common
Helina pertusa (Mg.)	Local
Helina reversio (Harris)	Common

HYMENOPTERA

VESPIDAE	
Vespa crabro (L.)	Regionally Notable (North England)
Vespula germanica (Fab.)	Common
Paravespula vulgaris (L.)	Common
POMPILIDAE	
Dipogon subintermedius (Magretti)	Local
ICHNEUMONIDAE	
Liotryphon crassisetus (Thompson)	Uncommon but widespread
Rhembobius praescrutator (Gravenhorst)	Common
Lissonata spp.	
EUPELMIDAE	
Calosota vernalis Curtis	Unknown
CHALCIDOIDEA	
Torymidae	
Torymus sp.	
Pachycrepoideus vindemiae (Rondani)	Unknown
Pteromalidae indet.	

SHORT COMMUNICATION

Notes on some wetland Lepidoptera in Surrey.—*Glyphipterix schoenicolella* Boyd (Glyphipterigidae). Adults of this species were numerous around tussocks of black bog-rush *Schoenus nigricans* growing along margins of flowing water in Folly Bog (SU9261). Moths were present from May to early September (17.v., 2.vi., 16.vi., 12.vii., 11.viii., 15.viii. 2000). This would appear to be the first record of this moth in VC17.

At the same site the purple-bordered gold *Idaea muricata* (Hufnagel) (Geometridae) occurs on the open mire areas, and from late June to mid July, adults were regularly encountered by day, flying rapidly, low to the ground. Porter (1997) states that marsh cinquefoil *Potentilla palustris* is the food plant, but as this plant is not found on Folly Bog, it must have alternative host(s).

Prochoreutis myllerana (Fab.) (Choreutidae). The map of this species provided by Heath & Emmet (1985) includes VC17 on the basis of unconfirmed records owing to the confusion with closely allied *P. sehestediana* (Fab.). I collected a female from Chobham Common (SU9765), which Graham Collins kindly identified as *P. myllerana*. This was one of dozens of *Prochoreutis* adults seen flying around skullcap *Scutellaria galericulata*, in warm but dull weather, on 3.viii.1998. The site was a recently cleared area of carr, over much of which the skullcap had spread.—J. S. Denton, 2 Sandown Close, Alton, Hants, GU34 2TG.

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